

ETES 5030/7030 Manufacturing Systems CTL Report

The Manufacturing Systems course is a split level technical content course required for technology education majors. This course integrates several of the major components of conceptualized teaching and learning (CTL) including problem based learning, project based learning, inquiry learning, collaborative/cooperative learning, and authentic assessment. A review of the syllabus and affiliated instructional material documents will provide evidence for each of these CTL components.

Problem Based Learning

The structure and nature of this course requires students to design, plan, organize, and develop a mass produced product using continuous line production techniques. Students are required to process through 19 unique phase of production planning starting with an idea of a product and culminating in the mass production of 22 mass produced products. Each phase of the process requires students to solve a variety of technical as well as human resource related problems. See the *Table of Contents* of the *Laboratory Manual* to review the phases of the problem based topics addressed in this course.

Project Based Learning

This course requires students to produce tangible technological artifacts as a result of the class activities. Teams of students (5-8) representing companies work collaborative throughout the semester to plan, design, and manufacture 22 mass produced products within a designated two hour period of time. Each product produced represents the combined efforts of the student companies and reflect the significant focus needed to achieve the production goal.

Inquiry Based Learning

As part of the manufacturing process and procedures within this course, students are encouraged to seek a variety of authoritative sources to solve the given problems. Sources such as technical manuals, resource books and journal publications, web-based data and information, as well as expertise from technicians and engineers are the primary resources for students to design and develop the manufactured products for this course. Students are required to submit documented evidence of the technical data they have used in manufacturing their products.

Authentic Assessment

Students are required to create a course portfolio that synthesizes all class activities, discussions, and experiences into a useful collection of materials. Students are to organize their portfolio into sections which address each of the 19 production phases of the manufacturing process. Based on the completed portfolio students from each of the companies are able to review and evaluate their efforts. See the description of the course portfolio as described in the course syllabus.

Collaborative/Cooperative Learning

In this course, students were sub-divided into groups representing 5-8 individuals. Each group represented the corporate leadership of a company and worked collaboratively throughout the semester to achieve the production goals set forth in the syllabus. The efforts of the student companies reflected both the strengths and weaknesses associated with any human resource organization and was designed to stretch the students to be able to work together in achieving their production goals. The collaborative efforts exerted by the students within their companies reflect some of the essence of CTL research and goals.

MANUFACTURING SYSTEMS ETES 5030/7030

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OFFICE HOURS: By Appointment - Phone 542-4503

REQUIRED TEXTBOOKS: Manufacturing Systems, Wright, R. Thomas,
(Goodheart-Wilcox Co., Inc. ©1990)
Manufacturing Laboratory Manual, Wicklein, R.C.,
(provided and part of lab fee)

DESCRIPTION OF COURSE:

This course focuses principally on manufacturing practices using the enterprise approach. Laboratory activities center around the developmental and production phases of a manufactured product.

COURSE GOALS:

The general goal is to provide manufacturing experience for students in the technology education instructional program. Emphasis will be placed on: the enterprise approach in teaching manufacturing within the technology education curriculum, the development of companies to manufacture a product, problem solving employed in the manufacturing of a product, and awareness of and literacy about the current state of manufacturing.

MY STYLE of TEACHING:

Classes will be conducted using the following teaching style:

1. Lectures, general discussions, and demonstrations (this means that you will need to be prepared to discuss course content and interact in class activities at any given time - there will be no passive learning).
2. Student presentations (research shows us that the best way to learn something is to teach it; each graduate student will lead a class discussion and/or demonstration related to course content).

FEES IN ADDITION TO TUITION:

There will be a \$10.00 lab fee associated with this course. This fee covers the cost of the laboratory manual and associated materials that may be used in production planning and tooling. All additional materials used in the production of the manufactured products will be the responsibility of the specific companies created during this class, as per the **Finance and Enterprise** section of the lab manual.

CTL – Problem Based Learning, Project Based Learning, Inquiry Learning, Collaboration/Cooperative Learning

GROUP REQUIREMENTS AND ACTIVITIES:

The following requirements and activities will be a major responsibility for each company that make up this class:

1. Organizing a manufacturing company
2. Planning production for the manufacturing company
3. Financing the manufacturing company
4. Developing production tooling for the manufacturing company
5. Training a work force for the manufacturing company
6. Producing 22 mass produced products within a 2 hour period of time
7. Creating a company portfolio depicting all phases of development for the manufacturing company

Group requirements and activities will account for 30% of the overall course point value.

INDIVIDUAL ASSIGNMENTS:

Several written assignments, to be done on an individual basis will be given to reinforce the major manufacturing presentations. The assignments are listed below and are presented in detail in the lab manual under the *Objectives and Assignments* section:

- Rationale for Manufacturing
- Product Development and Marketing
- Organization and Finance
- Production Planning
- Production Systems

There will be other individual assignments (eg., product idea, etc.) that are required, but are considered in your peer evaluation. Individual assignments will account for 25% of the total point value for the course.

MID-TERM EXAMINATION

A mid-term examination will be administered approximately half way during the academic term. This examination will address course content in its entirety (text reading, hand-outs, class discussions & demonstrations, etc.). The examination will be designed to determine your ability to comprehend course content and synthesize materials into a coherent perspective. The examination will be designed in an essay format. The mid-term will account for 15% of the overall course point value.

FINAL EXAMINATION

The final examination will be comprehensive in nature seeking to address every aspect of the course (text reading, hand-outs, class discussions & demonstrations, production planning, manufacturing run, etc.). The examination will be designed to determine your ability to comprehend course content and synthesize materials

into a coherent perspective. The examination will be designed in an essay format. The final examination will account for 25% of the overall course point value.

OTHER REQUIREMENTS:

Each student will be responsible for creating a documented student log of all of their individualized work assignments within their designated company. The student logs will be attached to the company portfolio and will be used to evaluate individual contributions to the company efforts. In addition, each student will be responsible for bringing and wearing approved safety glasses/goggles and following all safety regulations while working in the laboratory. This assignment will account for 5% of the overall course point value.

GRADUATE STUDENT SUPPLEMENTAL

Each graduate student will be responsible for leading the class discussion during a specified class period. This discussion will include a complete development of the topic assigned for the specific date. Graduate students are required to read, research, and design a well developed lesson plan which will include hand-outs, overheads (preferably electronic presentations - Power Point), as well as class lecture/discussion. Specific topical areas will be based on established course outline and will be available on a first-come basis. Evaluation will be based on the level of comprehensiveness, logical presentation, and innovation/interest generation. This assignment is worth an additional 10% of the overall course point value.

EVALUATION:

Individual Assignments	25%
Enterprise Project/Portfolio (group responsibility)	30%
Mid-Term Examination	15%
Other Requirements	5%
Final Examination	25%
TOTAL	100%
Grad Teaching Presentations	10%

GRADING SCALE (cutoffs based on percentage of total possible points)

A	90% and higher
B	80%
C	70%
D	60%
F	Below 60%

This scale will be used objectively in assigning grades. There is no grading curve in this course. For example, a student with a final percentage of 89.9% will receive a "B" regardless of how "close" it may be to an "A." You are responsible to give yourself whatever "safety zone" you feel is necessary to attain your targeted grade.

ATTENDANCE/PARTICIPATION

Attendance is crucial especially considering the amount of information covered in each class. Missing even one class could set you seriously behind. Class will start and end on time, so I expect everyone to be on time as well. In addition, I expect each student to take an active role by contributing and sharing thoughts and ideas, taking initiative, and seeking to help other class members. Each unexcused absence will lower your grade by 2.5% and you will be dropped from the grade roll if there are more than 2 unexcused absences. Each excused absence must be documented by a brief letter describing your reason for being out of class. All judgments about excused absences will be made at my discretion. Realize that if you are absent, even for valid reasons, you are still responsible for material and assignments discussed in each and every class.

LATE ASSIGNMENTS:

I expect assignments to be completed on time. My standard policy regarding assignments is 10% penalty for late assignments turned in within 1 week of due date and 50% penalty for assignments turned in thereafter until the end of the course (defined as the last regular class session). I use this system even in the event of "excusables," such as minor sicknesses or other unforeseen conflicts. However, any exceptions to this policy are made at my discretion.

DISHONESTY:

Cheating on class assignments, examinations, or other serious forms of academic activities will result in a grade of "F" (and a required report to University Officials). Persons "borrowing" someone else's work on an assignment will receive a zero on that assignment if it is the first offense. A second offense will be considered a serious form of academic dishonesty. (Borrowee is equally subject to penalties.)

WITHDRAWAL POLICY:

Withdrawal policy and procedures are described on page 39 of the undergraduate catalog.

Manufacturing Systems Laboratory Manual

ETES 5030/7030

**Dr. Robert C. Wicklein
University of Georgia
Department of Occupational Studies**

TABLE OF CONTENTS

CTL – Problem Based Learning, Project Based Learning, Inquiry Learning, Collaboration/Cooperative Learning

INTRODUCTION	1
MANUFACTURING ENTERPRISE FLOWCHART	2
<i>Division into Companies</i>	3
<i>Individual Ideation</i>	3
<i>Criteria for Products</i>	3
<i>Reach Consensus on Product</i>	4
<i>Elect Officers and Determine Responsibilities</i>	4
<i>Conduct Market Research</i>	5
<i>Develop Company Logo</i>	5
<i>Finance the Enterprise</i>	5
<i>Develop Prototype(s)</i>	5
<i>Prepare Working Drawings</i>	6
<i>Order Materials</i>	6
<i>Plan Production</i>	6
<i>Develop Production Tooling</i>	6
<i>Conduct Time Study</i>	6
<i>Conduct Trial Production Run</i>	7
<i>Develop Prototype Packaging</i>	7
<i>Hire and Train Personnel</i>	7
<i>Produce the Product</i>	7
<i>Market the Product</i>	7
<i>Dissolve the Company</i>	7
MANUFACTURING ENTERPRISE PORTFOLIO.....	8
OBJECTIVES AND ASSIGNMENTS	9
GENERAL PRINCIPLES OF PRODUCTION TOOLING.....	13
MANUFACTURING PRODUCTION CRITERIA.....	15
A PRIMER ON ADVANCED INDUSTRIAL TECHNOLOGY	16
<i>Introduction</i>	16
<i>Computer-Assisted Design (CAD)</i>	16
<i>Computer-Numerical Control (CNC)</i>	17
<i>Computer-Assisted Manufacturing (CAM)</i>	17
<i>Robots</i>	18
<i>Computers in Management</i>	18
<i>Computer Integrated Manufacturing (CIM)</i>	19
<i>Conclusion</i>	19
APPENDIX.....	20

INTRODUCTION

You are about to enter one of the most exciting educational experiences in your life. Though this may seem boastful, there is credibility in the statement because of what has happened with students in past classes. At the same time, you will probably put forth more effort and time into this class than you have in any other. You will have anxiety and relaxation, problems and the reward that comes from solving them, conflict and the relief that comes from resolution.

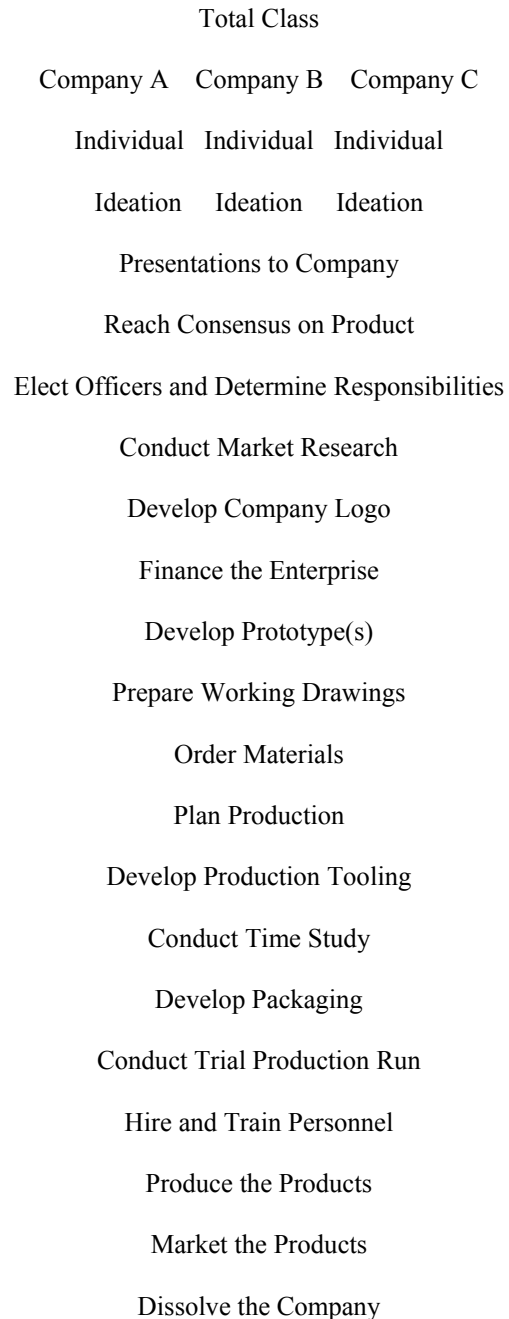
Part of the excitement lies in the fact that the class portrays the real world quite closely. You will be working with real problems, real products, and real money. You will be emotionally involved and thus your learning will remain for many years.

This laboratory/class manual is designed to help you succeed in what you learn (and the grade that is supposed to indicate your learning). It is also designed to help your company to succeed as an enterprise. The assignments, activities, organization, and objective approach have proven themselves to be effective over the past several years. The only requirement is that you read the manual and have it with you during class and in the lab.

The first section of the manual includes details on the enterprise approach used in teaching the course. You must become thoroughly familiar with it. The second part includes objectives for each of the major topics covered and corresponding assignments to reinforce your learning. It is designed to give you specific information on what is expected so that you need not play the traditional guessing game on what the instructor expects you to learn.

The Appendix includes multiple copies of several forms that you will need to do the assignments and complete documentation requirements for your company. Multiple copies of many of the forms are included. You will likely want to save at least one copy of each form for your future use and duplication.

MANUFACTURING ENTERPRISE FLOWCHART



The flowchart illustrates the overall organization of the class. In the following sections, each of the major portions of the flowchart will be explained in greater detail. It should be remembered that some of the activities on the flowchart must be done before others. Other activities may go on concurrently.

Division into Companies

Within the first week of the semester, the class will be divided into companies according to the enrollment in the class. Generally, each company will be comprised of four to six students. The division will be done by random assignment by the instructor. Occasionally, a student assigned to one company wishes he/she were assigned to another company. In addition, a group of students may wish that a particular student was not a member of their company. However, the purpose of this class is to simulate the real world. Dealing with individuals of varying personalities and motivation is part of the challenge of management in the real world, and is therefore part of the challenge of this class. Changes in the assignments will rarely be approved.

Individual Ideation

At the date designated, each member of the company will present an idea to the company of a product believed to meet the criteria of production. The presentation must be well-organized and clearly presented as it would in industry. Some means of communicating the idea to a group must be used. This would include an overhead transparency, an electronic presentation, an actual product, or a well-prepared sketch. If a sketch is used, sufficient copies for each member of the company must be provided. The product and the presentation will be evaluated by the other members of the company using a formal evaluation sheet (see Appendix). The following criteria will be used:

- Production Feasibility (Can the product be produced in our lab with the tools and equipment available?)
- Marketability (Is the product saleable beyond the members of the class?)
- Innovativeness (Does the product show creative thought?)
- Production Rate (Can the product be produced in sufficient quantity in a single lab period?)
- Class Criteria (Does the product meet the criteria for the class as detailed below?)

Criteria for Products

1. It is recommended that the product occupy a volume of no more than 24 in. x 12 in. x 12 in. No exceptions will be made.
2. The production of the product must be organized on a continuous line production basis. In other words, materials and sub-assemblies must enter the production system at the same time that finished products are leaving. This must be done efficiently and with good labor utilization.
 - a. "Subcontracting" is permitted with limitations. That is, processes which require inordinate amounts of time may be done in advance and will enter the production system as stock parts. However, such subcontracting should not exceed 10% of the total production effort and must be approved in advance by the instructor.
 - b. Examples of subcontracting include casting, gluing, metal machining, and certain finishing operations.
3. It is recommended that the product incorporate more than just one material.
4. The production system should engage 10-20 students. In other words, there should be that many work stations/operations.
5. The fair market value of all materials used for a single product should not exceed \$50.00. It is recommended that it be considerably less than this amount.
6. The production system must produce at least 22 units but not more than 30.
7. The total time for production of the 22 products must not exceed one regular lab period (two hours).

Suggestions:

1. A particular machine cannot be used for more than one operation. For example, if a product requires three holes to be drilled then three drilling machines (drill presses or portable drills) would be required. Note: This can be avoided by producing accurate tooling which can allow a machine to do multiple applications.

2. Avoid products that require extensive abrading (sanding).
3. Avoid processes or components that require close tolerances.
4. Use quick drying, easy-to-apply finishes such as lacquer (eg. Deft) or Danish Oil.
5. Think about how the product will be produced at the same time that you consider ideas for the product itself.
 - For example, how would you cut an irregular curve on the bandsaw accurately without creating a bottleneck?
 - How would you clamp glued stock and allow it to dry without making the situation impossible?
 - Remember, the time required for the slowest operation is what determines the rate of production. If a certain operation takes 15 minutes, then only four products can be produced in an hour. To produce 20 products in two hours, no single operation can take longer than six minutes per product!!
6. Consider the tools that we have available in our lab. If your product requires the drilling of four different holes and the lab has only three drill presses, there is a problem. Of course, tools can possibly be borrowed from other facilities for the production day. It may even be feasible for the company to purchase tools.
7. Games, toys, kitchen accessories, and desk accessories lend themselves well to production in a school situation. Do not let these suggestions limit your creativity, however.

Requirement: Idea from each student presented to class.

Reach Consensus on Product

Using the criteria as a guide, one or possibly two products will be selected for further development. The group must reach consensus on the selection of a potential product. Following the selection of the potential products further development can then proceed. This will generally involve the preparation of a prototype of the product(s). In many cases, several variations of the design of the product will be developed along with a prototype of each one. The best design will then be selected.

Requirement: Consensus on product for further development.

Elect Officers and Determine Responsibilities

Though it could be argued that the officers should be elected earlier, the most appropriate selection may be dependent upon the product selected. In any case, the company must decide what the title of each of the officers of the company will be and write a detailed description of each person's responsibilities. In addition, a chart illustrating the chain of command of the organization must be prepared. Each member of the company will be considered to have management responsibilities and should be included. The textbook should be consulted to help in these decisions. Once the management organization has been determined, appropriate individuals should be selected to fill the positions. Selection can be done through a formal election, informal appointment, or any other appropriate method. As in the real world, wise selections are extremely important. The success or failure of past companies have been dependent upon the quality of the leadership. Do not select a president for your company simply because he or she is popular or a "good guy."

Requirement: Titles, job description, and organizational chart for the officers of the company.

Conduct Market Research

It is very important to make sure that the product is marketable. Failure to do so has led to the demise of many companies. In simple terms, market research involves going to potential consumers of the product to get their opinion. There are options for when the market research can be done. First, it could be done to help in deciding a feasible product. Second, it could be done when the product is still in the design stage and is only in the drafted or mock-up stage. Third, it could be done after one or more prototypes have

been made. In this latter case, opinion could be sought to improve the design or select for alternatives. Whenever you decide to do the market research, a questionnaire must be prepared. The questionnaire must be approved by each officer. Data must be collected from at least 20 potential consumers of the product. Data may not be collected from technology education majors. Once the data are collected, they must be analyzed and a final report prepared. Decisions made on the basis of the market research are to be included in the report.

Requirement: Market research questionnaire and report.

Develop Company Logo

A company logo must be designed and approved by the company. The final version must be professionally done. Press-on letters, screen process printing, air-brush, artistic rendering, etc. are recommended. The logo must be 16 in. x 24 in. in size and be framed or mounted on a rigid material. It must be displayed in the lab by the date required.

Requirement: Final rendering of company logo displayed in lab.

Finance the Enterprise

Your company is responsible for raising all capital needed for the enterprise. This includes all wood, metal, fasteners, glue, etc. All materials must be purchased from outside vendors and contracts must be made by members of the company. The materials for the prototype will be furnished by the department in exchange for two final products. One popular method of financing is to sell stock certificates. These certificates are redeemable for one product when production is complete. Stock could also be sold and then assets distributed among stockholders when the company is dissolved. Profits of the enterprise would be distributed in this manner. A written description of how the company is to be financed must be submitted and approved before any money is collected. In the past, this has been an area of conflict within the company, so make sure your plan is thorough and well thought-out. Every financial transaction must have a record (receipt or bill). Consider opening a checking account and do so early in the semester. Be sure to include in the plan how the remaining assets of the company will be distributed. In any case, it is assumed that your company will be operated as a corporation. Therefore, it is necessary to prepare a neat, sample stock certificate.

Requirement: Sample stock certificate and financial plan.

Develop Prototype(s)

A prototype is a one-of-a-kind version of a product. It is a fully-working example of the product. As mentioned before, several different prototypes may be developed by a given company. When finally accepted, it is the master for the production of the products and will be used extensively by the company in tooling and planning.

Requirement: Final prototype approved by the instructor and the company.

Prepare Working Drawings

If believed to be in the best interests, the prototype(s) could be prepared from good quality sketches. But once the prototype is finalized, complete working drawings with detail drawings of each piece must be prepared. Copies of the complete set of drawings must be distributed to each member of the company. No tooling can be constructed until this has been done. All drawings must be on standard 8 -1/2 in. x 11 in. white paper. It is recommended that a sheet be prepared with the necessary border and title block (including logo if possible). Copies of this master would then be used for all the drawings done by members of the company. Requirements: Assembly drawings, detail drawings, and bill of materials submitted and approved by the company and the instructor.

Order Materials

As mentioned previously, all materials must be secured from outside vendors by members of the company. Receipts must accompany all expenditures. Remember to allow for shipping time if ordering from distant sources. Shop around and make the best buy.

Plan Production

Each product is made up of subassemblies. Each subassembly consists of one or more parts. Each part is produced by a series of operations. An operation in continuous line production is generally what is done by a single operator working at a work station. Each operation can be analyzed into a series of elements. To clarify, consider brushing your teeth as an operation. Removing the cap from the tube, applying the toothpaste, brushing, replacing the cap, etc. would be elements of that operation. Every single operation necessary to produce the product must be determined, listed, and analyzed. This is done using an Operation/Routing Sheet (see Appendix). Then, each operation is further analyzed using a Flow Process Chart. Finally, the production is organized within the facility or plant, resulting in a Plant Layout or floor plan showing the flow of production. Remember, in planning for production, that a given machine can be used for only one operation or work station. In other words, one could not rip one part on a tablesaw and then crosscut that part or another on the same tablesaw.

Requirement: Routing/Operation Sheet, Flow Process Chart, and Plant Layout prepared and approved by the company and the instructor.

Develop Production Tooling

This involves the design and construction of the jigs and fixtures necessary to make repetitive operations efficient and accurate. This will occupy much of the time and is one of the most creative and challenging activities. Generally, each member of the company is assigned a specific operation or work station for which he/she has responsibility. After the tooling has been finalized, assembly drawings of each piece of tooling must be prepared on the company's standard drafting paper.

Requirement: Tooling and draftings thereof.

Conduct Time Study

Once all the tooling has been developed for a particular operation or work station, a time study must be conducted. The operation is done three to five times by an operator and it is timed. The operation is observed and recommendations are made on how the operation can be optimized for greater efficiency. A determination of bottle-necks can be made and, if needed, two or more work stations in which the same operations are done can be developed.

Requirement: Time study report for each operation.

Conduct Trial Production Run

This is the ultimate key to production success. It involves setting up the entire production system and going through each operation. Final time data are collected. All members of the company participate and critique the system. Problems unknown to this point become apparent. Final revisions are made. The production run should be done three to six days in advance of the actual production date.

Requirement: Conduct the trial run and correct problems.

Develop Prototype Packaging

One prototype package must be developed. The package should be of professional quality and very neatly done. Press-on letters, etc. are recommended.

Requirement: One prototype package.

Hire and Train Personnel

The four to six members of the company can not provide the labor necessary for production. Therefore, members of the other companies must be "hired". In addition, students from other classes or even roommates, friends, etc. can be recruited. This not only provides needed labor, but it is good public relations for the class and technology education in general. Because of this, each work station should be designed for operation by someone other than the "engineer" who designed it. This, of course, is what really happens in industry.

Requirement: Train personnel.

Produce the Product

This is where it all comes together. It is the fruit of the whole semester's efforts. It is a tense but very exciting experience.

Requirement: 22 or more products in one, two-hour lab period.

Market the Product

The product must now be traded in exchange for cash. This is where the ultimate purpose of any corporation is realized - to make a profit!

Requirement: Sell the products.

Dissolve the Company

When everything is done, the company is dissolved. All the debts are paid, all assets are liquidated according to the financial plan that was established. The final financial report of the company is prepared and distributed.

Requirement: Financial report

MANUFACTURING ENTERPRISE PORTFOLIO

All activities, functions, planning, designs, etc. must be presented in a well documented and organized portfolio. The following materials are to be submitted in the form of an attractive portfolio (notebook) at the specified time by each company for evaluation:

1. Company name and officers
2. Company trademark/logo - also to be displayed in the lab
3. Market Research form and analysis
4. Complete working drawings of the product (individual parts & completed whole) and production tooling.
5. Bill of materials
6. Operation/Routing sheets
7. Operation Process Chart
8. Operation Process Chart - Display (with photos depicting each process)
9. Flow Diagram
10. Two (2) products
11. One (1) prototype package
12. Quality Control System
13. Complete financial report
14. Complete daily log of all company activities

Manufacturing Production Criteria:

- Twenty-two (22) units of a product must be produced.
- Total production time must not exceed a two (2) hour time period.
- The product must be able to fit into a box that does not exceed two (92) cubic feet in volume.
- Production should involve all students in the class.
- The fair market value of all the materials for a single unit must not exceed fifty dollars (\$50.00).
- The production of the product must be organized on a continuous line production basis. In other words, materials and sub-assemblies must flow effectively from one work station to another with good labor utilization.
- Each work station must be “manned” by a specific individual assigned to the station - using the same worker for more than one job is not permissible. Depending on production needs, it may be necessary for class members to recruit UGA students to be production line workers during the trial and production runs.
 - “Sub-contracting” is permitted with limitations. That is, processes that require an inordinate amount of time may be done in advance and will enter production as stock parts. Such sub-contracting must not exceed 10% of the total effort of manufacturing. Examples of sub-contracting include casting, metal machining, gluing, etc.
- All materials for the product are to be ordered and purchased from outside vendors. A moderate amount of materials will be supplied for prototypes and production tooling.